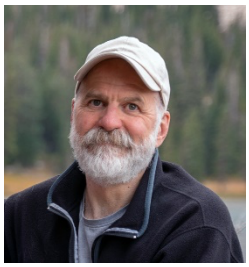
Invited presentation to the Geological Society of Washington DC, [virtual] October 25, 2023

Geologic hydrogen: An overlooked potential primary clean-energy resource

Geoffrey S. Ellis
U.S. Geological Survey, Denver, CO USA

Although natural hydrogen in the subsurface of the Earth is well documented in a variety of geologic environments, economic accumulations of natural hydrogen have generally been assumed to be non-existent. Recent discoveries in Africa and elsewhere have challenged this notion, and there is a growing acknowledgement that geoscientists have not looked for natural hydrogen in the right places with the right tools. Model predictions based on the known behavior of hydrogen in the subsurface and geologic analogues indicate a global resource potential in the millions of megatonnes (Mt), a fraction of which could meet projected demand for hydrogen for hundreds of years. While much is known about the occurrence of subsurface hydrogen (e.g., generation mechanisms, consumptive processes, etc.), there is currently a lack of understanding of the processes and settings that are most conducive to the formation of significant accumulations of hydrogen. To develop effective strategies for exploration and assessment of geologic hydrogen resources, a comprehensive framework is required that could lead to the discovery of economic hydrogen accumulations.

The U.S. Geological Survey has developed a "hydrogen system" model for understanding the potential generation of economic accumulations of geologic hydrogen based on the "petroleum systems" concept. The essential components that make up the models (e.g., source, migration pathway, reservoir, seals, etc.) are the same but the details of each of the components vary and may not be directly comparable. Given our nascent understanding of geologic hydrogen, many components of the hydrogen system are highly uncertain. However, the uncertainty associated with each of the essential components of the hydrogen system can be estimated and used to assign risk. This presentation will discuss what is known about the potential for natural hydrogen resources, the geologic model for natural hydrogen accumulation that has been developed, and the major gaps in our current understanding. Additionally, details of ongoing efforts to map hydrogen prospectivity across the US and plans for further research to refine the hydrogen system model, improve geologic hydrogen prospectivity mapping capabilities, and reduce the associated uncertainty (i.e., risk) will be presented.



Dr. Geoffrey Ellis is a research geologist and the project chief of the Potential for Geologic Hydrogen Gas Resources project within the Energy Resources Program (ERP) of the U.S. Geological Survey. He is also an affiliated faculty member in the Department of Geology and Geological Engineering at the Colorado School of Mines and the chair of the Hydrogen Resources and Storage Committee within the Energy Minerals Division of the American Association of Petroleum Geologists. He holds an A.B. in Geological Sciences from Cornell University, an M.Sc. in Geochemistry from the Colorado School of Mines, and a Ph.D. in Marine Geology and Geophysics from the University of Miami. Prior to joining the ERP, he worked as a staff scientist in the Division of Chemistry and Chemical Engineering at the California Institute of Technology, as a research chemist in the Water Resources Division of the USGS, and as a consultant in environmental and resource exploration geochemistry. His research interests include organic-inorganic interactions in geologic settings, gas isotope geochemistry, and the potential for natural hydrogen resources.